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An Adaptable Optimal Network Topology Model for Efficient Data Centre Design in Storage Area Networks

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Abstract—In this research, we look at how different network topologies affect the energy consumption of modular data centre (DC) setups. We use a combined-input directed approach to assess the benefits of rack-scale and pod-scale fragmentation across a variety of electrical, optoelectronic, and composite network architectures in comparison to a conventional DC. When the optical transport architecture is implemented and the appropriate resource components are distributed, the findings reveal fragmentation at the layer level is adequate, even compared to a pod-scale DC. Composable DCs can operate at peak efficiency because of the optical network topology. Logical separation of conventional DC servers across an optical network architecture is also investigated in this article. When compared to physical decentralisation at the rack size, logical decomposition of data centers inside each rack offers a small decrease in the overall DC energy usage thanks to better resource needs allocation. This allows for a flexible, composable architecture that can accommodate performance based in-memory applications. Moreover, we look at the state of fundamentalmodel and its use in both static and dynamic data centres. According to our findings, typical DCs become more energy efficient when workload modularity increases, although excessive resource use still exists. By enabling optimal resource use and energy savings, disaggregation and micro-services were able to reduce the typical DC's up to 30%. Furthermore, we offer a heuristic to duplicate the Mixed integer model's output trends for energy-efficient allocation of caseloads in modularized DCs.

Keywords-Data centres, Optimal topology, Optical networks, decentralization, energy savings, Network latency.

I. INTRODUCTION

Data centres are essential facilities because they facilitate the widespread use of digital technology. These critical systems fulfil the needs of cloud data processing and analytics applications by providing the computational resources necessary to operate [1]. On-demand dynamic provisioning, failover clustering isolation, parallel processing, and security are all necessary. Applications in this category include the likes of online services, web-search, texting and social networking sites, networked system files, statistics, and digital distribution. The rapid development of technological developments like content delivery network (CDN) portability, IoT, AI, KA, and SG&C suggests that data centres (DCs) will soon experience an increase in the amount of implemented programmes. [2].

Managing and orchestrating systems, energy and cooling systems, and other ancillary components are essential to the day-to-day management of data centres (DCs), which consist of computing, storage, and network resources. Warehouse-scale data centres are built using servers, the fundamental building block of conventional DCs. It's a configurable node with limited processing power, storage space, and connectivity. Storage systems like storage area networks (SANs) and network-attached storage (NASes) have recently become the de facto standard for centralizing data centre (DC) storage resources (NAS) [3].

Racks are cabinet-like structures that may house up to 48 servers, with each server in the rack connected to each other through an intra-rack communication network. A data centre site or cluster is made up of many servers linked together. Data centres (DCs) have been categorized into three subsets depending on the types of institutions that control and run the underlying infrastructure and the types of applications housed there. The data centres (DCs) of universities and private businesses are on-premises infrastructures with a few hundred servers at most, but the DCs of cloud providers typically consist of tens of thousands of servers, some of which may be distributed across the globe to meet quality of service and regulation requirements [4].

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Given the expected increase in DCs and the number of applications operating in their underlying infrastructures, it is crucial to improve the flexibility, resource utilization efficiency, including power generation of DCs in order to achieve the manner in order to achieve at low expense and low power efficiency. Nevertheless, it is well knowledge that a conventional DC system has its drawbacks. There is a significant chance of workload blockage because to resource dispersion and utilisation inefficiencies, costly infrastructure capital expenditures and operational expenditures, and poor compatibility for a wide range of developing applications. [5].

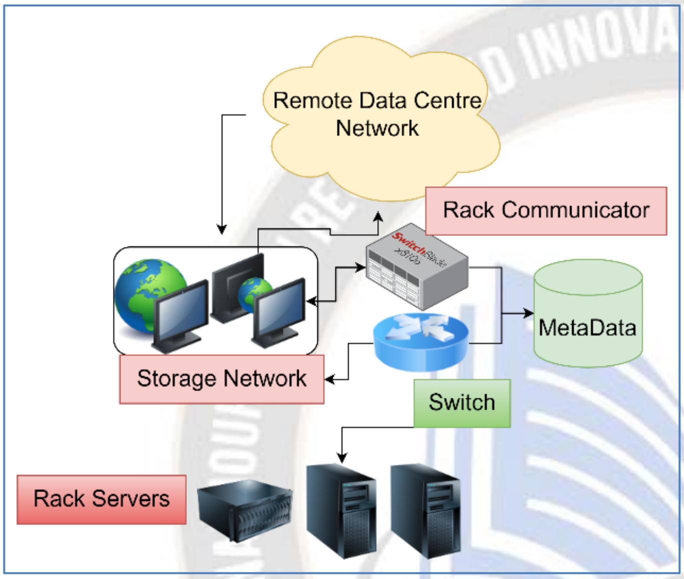

Figure 1. Conventional Storage Area Network model

Traditional data centres' inflexible design makes it difficult to include and mainstream cutting-edge hardware innovations like developing storage class memory, which offers greater capacity and lower latency than conventional hard disc drives. Togetherhypothetical and practical discussions on DC organization have turned to ideas such server modelcontrol and deployment defining of DC properties to overcome these shortcomings [6]. Furthermore, the adventuring into new DC infrastructures is inspired by the narrowing performancebreachamongdeveloped and conventional interactingapproaches like exteriormoduleinterrelate express and Ethernet. Disaggregating conventional server resources into separate computation, stockpiling, and network pools is a prerequisite for composing DC architectures.

Decomposition and re-composition of these virtual computing systems is possible with the help of such programmed accessible administration and rulecoat accessible through a standardAPI (Application Programming Interface). This capability allows for a more adaptable infrastructure with a more malleable pool of resources. A custom task of any size or kind can have its resource needs met by composing resources from this pool on demand. Software defined infrastructures (SDI) allow for a consolidated layer of administration and control to be applied during the composition of distributed data centre (DC) resources [7]. Software-defined infrastructural facilities esoteric the fundamental tangible computing resources, connection, and disk storage to allow for automated workload-based constituents, surveillance, and governance of DC resources through a centralized operating system which can adaptively modify conceptual understanding to preserve created framework by the task.

Virtualization of servers, networks, and storage all play crucial roles in SDI. Furthermore, customizable groups of underlying hardware that may be provided based on workload needs are made possible across the professionallucioditylevel as well as the management controller layer of SDI. In this study, we assume that SDI and its underlying technologies are already in place and instead analyze the most efficient method for determining how much of a scale to apply to resource disaggregation in the context of a well-defined software system. Server resources can be physically disaggregated at several levels of granularity, including the rack and the pod [8]. Specifically, nodes with diverse resource types like Processor, memory, disk, and Ethernet are allocated to a rack to guarantee systemorganizationconfiguration inside a layer, or over the next control, at rackscale. Co-rack resources are the only ones that can access the resources in their own rack. To guarantee compute system composition inside a pod, deviceshavingidenticalcomponentshave been assigned for a layer, and layers of various component kinds are assigned to a hub. Each rack in a pod has resources that may be accessed by other components in the pod.

The major contributions for this research article are as follows:

- Composable distributed computing systems (DCs) appropriate networks are discussed. For the first time, a comprehensive model of network architecture is presented.
- Network topologies such as electrical, optical, and hybrid are used as points of reference to back up the variety of composable DCs under consideration. The results of varying the placement of processor and storage-dependent allocations are analyzed.
- Parallel to monolithic workloads, the implementation of service-based allocation to construct unitedassignments in redesigned DCs is also studied. For the first time, a heuristic is presented that allows overliveliness competent distribution of assignments in flexible DCs.
- When all is said and done, this report provides an in-depth analysis of the obtained results.

II. LITERATURE SURVEY

The ability to disaggregate data centre resources into separate pools in order to build a composable infrastructure relies on the

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availability of a networktopology that can handle a significant increase in network traffic while maintaining a latency profile that is close to that of traditional infrastructure [9]. Some network topologies supporting rack-scale as well as pod-scale disaggregation in configurable DC infrastructure have been suggested in the current literature. Switching components and linkages in these networks are either electricity based, hybrid, or photosensitive.

Here, we take a look at a few of these network architectures and group them into categories according on whether they use optical, electrical, or hybrid components. These connections, as broadcasting to communicate DC reserve, does not alter our categorization because their use is commonplace in large-scale DCs. This means that hybrid network architectures need to make use of both electrical and optical switches. Intel's spatial orientation for data centre design, the Rack Magnitude Design (RSD), advocates for a hierarchical Ethernet swapping framework to connect substantially consolidated components. The widespread use and inexpensive cost of Ethernet switches are often cited as main justifications for their integration into network architecture [10]. A Ten Gigabit ethernet Network Interface Card (NIC) on each reference model node establishes a connection between the node and a ToR Ethernet switch in a rack with similarly resourced nodes. Each rack in a pod has its own ToR switch, which is connected to a data centre (DC) aggregation switch that bridges the gap between the pods themselves and the ToR switches outside of the pods.

Connections to other networks can also be made using aggregation switches. If desired, the Intel RSD may also function with a bottom rung of the network, when these switches are installed in rack drawers serve as intermediary shifts among the rack's service modules and the ToR switch. The suggested network topology is supported by Intel RSD with optical connectivity at all layers. In addition, a structure of network enabling servers configurable DC systems was presented [11]. The electrical ToR switch serves as the network's central node, connecting all of the various cloud node controllers. Despite the fact that a multi-tiered transition network is provided between ToR switches, the topology may also permit a full-mesh or torus connection within the rack among network monitors on different system devices.

For data centre networks that make use of modular I/O, storage, and accelerators, other works recommend using electrical switches like PCIe and InfiniBand switches. However, due to the comparatively significant toggle access frequency of electrical switches, the effectiveness in terms of sensitivity to latency programmes running in DC infrastructures with distinct processor and storagemechanisms may dramatically suffer. A group called Gen-Z has recently presented a switching fabric that can connect disjointed CPU and memory elements with latencies of less than 100 nanoseconds. Electrical switches like this can prevent a noticeable drop in performance for latency-sensitive software [12].

This Gen-Z collaboration is an industry-driven group working to develop a new computer design that allows for the separation of the central processing unit (CPU) and the random-access memory (RAM). Gen-Z allows for the direct and switch fabric connected connectivity of disaggregated computing components. Several proposals for optical network architectures have been madein the case of modular data centre systems to take use of the benefits of optical networks over electrical networks, including such data rate and transmission format relativism, an expansion of multiplexing regions, and energy efficiency [13].

Anonymised computing resource topologies rely exclusively on optical components and linkages to transport data between their many parts. Optical network topologies were presented for rack-scale, flexible DC infrastructure in the study. Packet forwarding among nodes in the composable DC is handled by specialized FPGA-based switch interface cards (SICs) existing on each homogeneous resource node. Along the inter-resource communication channels, these topologies use active wavelength selective switches (WSSs) or detachable arrayed-waveguide grating router (AWGR) based toggles and optical circuit switches (OCSs).

In the first network topology version, known as DORIS, WSS-based switches serve as ToR switches by linking blades of shared resources located in the same rack and establishing communications with blades of shared resources located in adjacent racks. All the ToR switches are linked to the WSS-based ToC switches at the top of the cluster, which in turn are linked to the inter-DC switches by means of optical fibre. DORIS allows for both both direct and indirect (through the ToC exchange) connectivity between racks within a cluster, while optical inter-DC switches are used for inter-cluster and internet-facing communication. For the dRedBox project's rack-scale architecture, we suggested an optical network topology with many layers, very similar to Intel's RSD network layout [14].

The composable DC architecture relies on a rack-scale design in which identical resource modules are housed in trays and then stacked in racks. High-speed optical transceivers connect each resource module to the rest of the network. With the addition of FPGA programmable logic, CPU resource modules may execute layer 2 switching functions in the network architecture and serve as intermediary switching nodes [15]. Each tray's lower level network is an intra-tray network comprised of links between homogeneous resource modules located within the tray and one or more optoelectronic edge of tray (EOT) converters. The second layer of the network architecture is formed by connecting each EOT switch in a rack to a high radix optical ToR circuit switch.

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III. PROPOSED SYSTEM

Our goal in writing this study was to examine the various network architectures proposed for use with composable DCs and to draw comparisons between them. For the three types of topologies we've discussed—electrical, optical, and hybrid—we pick one as a stand-in. Depending on the need, we modify each example architecture to work with either a conventional DC, a rack-scale DC, or a pod-scale DC. Intel RSD's default electrical network layout is a multi-tier configuration. Reference optical networks are those based on EVROS, whereas hybrid networks are those based on the network topology.

Algorithm 1: Topology Selection

Steps:

1. Arrange the workloads based on the demands in descending order.

2. Choose any one workload with unused demand.

3. For any node n of the network do

a. Calculate query workload

b. Find the node with best values.

4. Check for the availability of the required node.

a. If not available identify the workload and go to step 2.

b. If available use the best identified node for service provisioning.

5. Release the identified the provisioned node from the list after completion.

6. Estimate Power consumption of the provided network topological structure.

7. Choose the best one according to the energy consumption.

Communications between racks or clusters in a data centre may be established with the use of optical switches located on the topmost tier of the architecture. However, several network designs for flexible DC infrastructures have taken advantage of both optical and electrical components. Rack-scale, flexible data centre architecture was presented using a hybrid network topology. A rack-local optical switching, acting as a fast-optical backplane, enables communication within a rack between compute and distant memory blades. The composable DC architecture's outbound communications travel over a second backplane that extends from the rack into a hybrid leaf-spine topology.

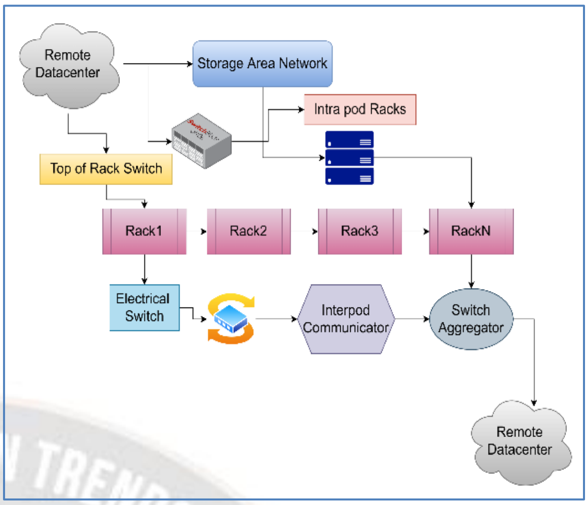

Figure 2. Proposed System architecture

For composable DC infrastructure on a pod size, alternative hybrid network design was developed. Each rack of consistent resources is equipped with two sets of switches in this design. First-tier electrical transitions interact with ToR non-blocking fiber optics to create a communications system across adjacent racks, and first-tier operational amplifiers give access for every intra-rack commodity node.Since each tray in dRedBox's recommended network architecture contains a layer 1 electrical connection switch, the whole setup may be thought in terms of a hybrid routing protocol.

Each pod has one or maybe more towers, and each module contains three or more capacity components, as described by the guideline reusable components DC architectures.Assuming physical separation is carried out on a large enough scale, every rack in a DC of pod size houses just one type of resource.Just at the pod level is it possible to build a logical domain controller. Rack-scale physical resource disaggregation, on the other hand, allows for a mix of resource types to be housed on the same nodes inside the same rack. Thus, a rack's worth of servers may function as a single logical unit.

Traditional data centres include many nodes in each rack, and these nodes are often physically separated from one another. Therefore, a rack node can function as the physical server for a logical server. There are two places in the infrastructure configuration where a memory resource component is needed. In the first, the role of random-access memory (RAM) in traditional computer architecture is fulfilled by a memory resource component. Since in-memory computing is typically suspected for organizations of workloads deployed in the DC, a memory resource component also serves as a storage device. To lessen the stress on the central processing unit (CPU) and the operating system (OS), it is anticipated that these types of workload groups employ in-memory data shuffle through remote direct memory access (RDMA).

Therefore, network inter-memory traffic is generated according to where workloads' memory resource requirements

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are met. A MILP model is developed to minimise the total electricity consumption of adaptable DC systems relative to the baseline electromagnetic, combination, or optical network architecture.Considering allocation of funds in reusable components DC architectures and activity patterns supplied by an execution engine placed astride the physical infrastructure layer, the model calculates the ideal locations for every type of resources and functions by each job.When opposed to using dedicated network storage, the simulated DC architecture's use of data retrieval via a coherent routing protocol that supports both LAN and SAN connection via a specialized offload NIC yields significant efficiency gains in terms of storage.

Thus, in the DC, Processor or reminiscence communication to and from IO constitutes both Subnet and upper traffic.Every bit of northbound IO traffic in a data centre constantly originates at an inter-DC toggle connection, and every bit of downstream IO information consistently terminates at a downstream functionality. The inter-data-center switch then forwards the data to either the computing nodes, the Internet, or the separate SAN. After compute disaggregation, the local cache of the CPU resource components employed in the model is large enough to facilitate remote memory access. Further, in order to do an apples-to-apples comparison, we assume that the reference network architecture is in an uncapable condition. Further model simplification is possible by assuming, as is reasonable under ideal conditions for each standard network design, that data transmission is directed through the shortest distance.

The proposed approach suggests the following ways of finding the workload analysis as:

$$T_x = \sum_{k \in DS} XDM_{xk} \; \forall x \in X$$

Calculating the overall network energy consumed of electromagnetic, composite, and optical networking topologies is as follows, given each architecture, the load proportionate energy consumption of network elements visited, and certain factors as follows:

$$\sum_{d \in DS} \sum_{n \in NS} \sum_{x \in X} Z_{xdn} + W$$

With satisfying the following constraints as well:

$$\sum_{x \in X} XD_x XDM_{xk} \leq D_k$$

$$\forall k \in DS$$

When some tasks cannot be provided, the suggested approachminimizes the overall energy usage of Computational power, storage, the structure of network employed across the DCs, and the quantity of unused applications. Each rejected task has a corresponding cost, expressed in Watts.

A monolithic workload is characterized by its constant need for resources and its intended execution on dedicated hardware, either real or virtual. The micro-service architecture is an unconventional workload architectural style that proposes breaking down monolithic workflows into smaller, more manageable pieces called micro-services. Each micro-service is responsible for a single business function and can be independently designed, tested, deployed, controlled, and expanded. Subsequently, these interdependent micro-services carrying out separate business operations are provided simultaneously to generate a modified one that is analogous to the disassembled monolithic one. For instance, this may be separated into three separate microservices that together create a single interconnected workload, with each microservice responsible for a specific aspect of the e-commerce process, such as bookkeeping, inventory management, or order placement.

This approach minimizes the overall DC resource energy usage for a particular device that require processor or storage resources and include inter-resource data transmission. Because the heuristic takes a greedy approach, they are sorted in descending order of CPU/memory resource needs relative to the activity class underneath evaluation to reduce the likelihood of blocking caused by workloads with extremely vast requirements. Hereafter referred to as the job list, the workload list serves as the input to the algorithm. The query defaults to the workload that appears at the top of the task list.

The main administratorutilizes a division strategy, probing each node in the DC for something like processor as well as storage element available, so as to provide the query burden evenly among the available nodes. Each node, if possible, will return a candidate central processing unit and/or reminiscence element to provide the query demand, together with the node's power consumption and usage statistics for that component. In the event that no rack has sufficient Processor and storage available resources to execute the request activity, the workload will be terminated and removed from the work plan the workload reservation criterion. When such is not the case, the central orchestrator uses component usage levels to determine which CPUs and memories should be used to furnish the query demand in each rack.

The suitable candidate's CPU element in each rack is then utilized to determine which rack the central orchestrator will choose to provide. Finally, the optimal pod to furnish is chosen by the central orchestrator based on the usage limit of the strongest choice CPU element in the best qualified rack of every pod. This query task is then taken off the jobs list. Following these procedures, the algorithm will go through all available resources to find the ones with the most suitable hardware configurations to accommodate each workload's specific resource requirements. If the task queue isn't empty, the heuristic will try to find the next enquiry workload that can be accommodated by the available but underutilized resources in the best rack at the moment. The scan makes an effort to

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utilize the greatest CPU component currently available to its fullest potential while processing resource-intensive applications.

The reason for this is because the components of a CPU have a larger peak power consumption than the components of a memory system. The scan sorts jobs in increasing order of overall Processor capacity requirement severity, prioritising those with a higher demand above those that place a greater burden on memory.To ensure Computation allocation of resources, ultimately results in optimal overall DC energy load requirement, memory-intensive tasks are given less weight when calculating resource requirements. If the scan is successful, the returned workload will replace the query workload in the best rack. In this case, the unsevered task with the highest ranking in the job list is chosen to become the new search workload. Following the placement or blocking of all workloads, the algorithm assesses the overall network power consumption due to the placement of workloads' CPU and memory resource demands throughout the DC and then presents the total DC resource power consumption.

To avoid a stalemate, the algorithm always chooses the first available option. If the lower utilization threshold (k) established for that component class is lower than the utilization (U) following the placement of a query for resources. Its upper utilization threshold (k) for class k components is exceeded if the equivalent usage (U) after placing the query resource usage is higher. If it is the very last option on the list of candidates being considered tomeet the resource requirements of the query.

IV. RESULTS AND DISCUSSION

Comparing the efficiency of modern "composable" data centres, which use rack- and pod-level physical resource disaggregation, to that of more conventional "traditional" data centres is done with the use of the MILP model. To mimic the diversity of real data centres' hardware, we've decided to use a diverse processor and storage. Aside from a constant power draw when idle, the power profile of each processor and storage is linear in relation to load. The ratio of active power consumption to total resource capacity is the influenceaspect, that indicates the grade of the directinfluenceoutline.

TABLE I. TABLE TYPE STYLES

Network ID	Processor(GHz)	Memory (GB)
1	1.8	3.8
2	2	5.9
3	1.5	6.8
4	3.2	6.9
5	2.1	6.7

This is the foundation upon which the relative workloads of each CPU and memory module may be determined. Nonetheless, it is not possible to draw any firm conclusions about a resource's energy efficiency from only its power factor. This is due to the fact that a supplyconstituent with a smallauthorityinfluenceis with limited dimensions and so may meet only a limited amount of supplyrequest. When the supremacyfeature of several mechanisms is normalized by their respective capacities, the resulting metric is a more accurate representation of their overall energy efficiency. All proposed network topologies' electrical and optical power consumption is measured and compared using the parameters.

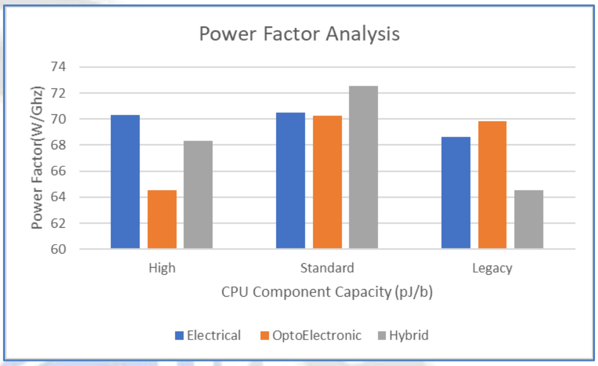

Figure 3. Topology Based Power Factor Analysis

The findings obtained when 20 CPU heavy workloads are properly provided reveal that, across various models, the conventional DC architecture has the maximum number of active DC capabilities and the second lowest explicit memory resources use. These results corroborate the generally acknowledged difficulties of supplying monolithic workloads in conventional DCs, which are typified by inefficient use of DC resources. Workloads that rely heavily on central processing units (CPUs) are a major contributor to traditional DC's higher median continuous CPU resource utilization.

In contrast, the utilization scattered is less energy efficient than consolidating workloads into a few active racks because to the existence, that are high indolentinfluencefeasting, in the lower echelons of various network architectures. As a result, only a small fraction of racks in conventional DCs are actually put to use, resulting in a lower TDPC. The TCPC and TMPC of a conventional data centre with an optical network topology are, for instance, 6 percentage points and 11 percentage points for a conventional data centre with an electrical or hybrid network topology.

Keep in mind that prescriptive energy locality respectively the CPU and memory components that host so every quantity of work, as well as resource capacity constraints, limit the ability to cluster the recollection bandwidth utilization of numbers of cases that owe allegiance towards the accurate relatively similar load - balancing collective into a single memory component in the traditional DC. Consequently, communicating between memories intermediaries at different

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nodes via memory data obfuscation has no impact on the distribution of responsibilities in a typical DC. There's going to be memory - mapped shuffle traffic across nodes if two workloads from the same activity group that need inter-memory interface are installed in separate nodes.

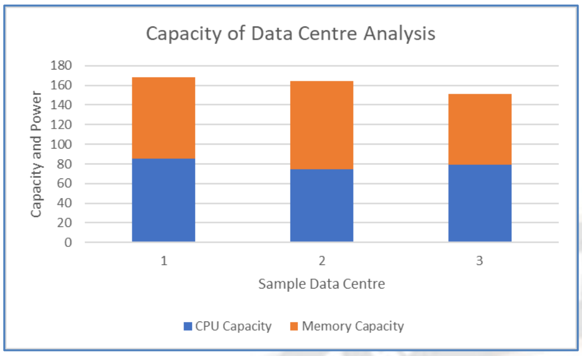

Figure 4. Data Centre Capacity Analysis

It was revealed that the placement of operations' reminiscence capacity planning in rack-scale DC had also been impacted by the energy usage characteristics of flipping elements when CPU-intensive workforces were delivered. In a typical DC, the Processor and storage are physically separated into nodes with varying amounts of storage and processing power, known as conceptual decentralization, and that each rack in the DC has its own dedicated resources to ensure latency-related service level agreements are met.

This is in contrast to the case in a conventional DC, where the localization of resources is restricted to individual nodes. Incorporating logical fragmentation to a conventional data centre (DC) has the potential to boost throughput and put it more in line with that of a rack-scale DC.

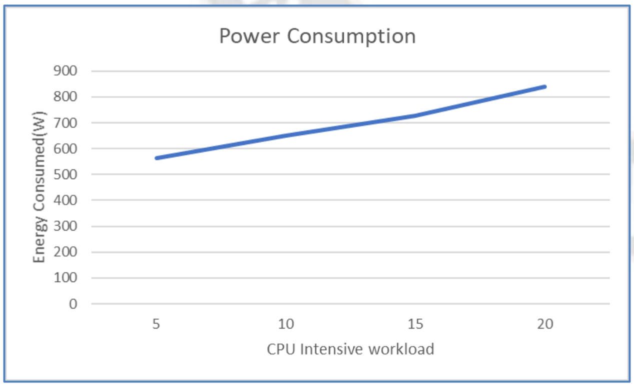

Figure 5. Power Consumption achieved for CPU intensive workloads

The performance of conceptual decentralisation in traditional DC is measured against that of a truly anonymized rack-scale DC by comparing their respective power consumptions. As in the previous situation, optical communication topology is applied in both.

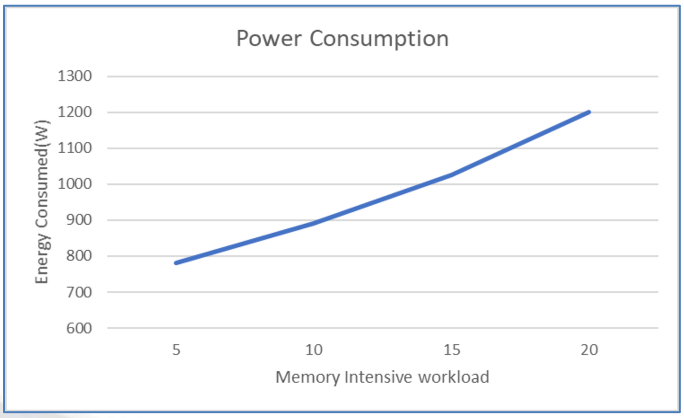

Figure 6. Power Consumption achieved for Memory intensive workloads

V. CONCLUSION

Under this study, we developed a network model to compare the efficiency of rack-scale and pod-scale practical decentralization of computing resources using multiple electrical, optoelectronic, and hybrid network architectures. Physical breakdown of computational resources at the rack level was shown to be adequate for achieving optimal resource utilization efficiency, even when compared to resource disintegration at the pod level in composable DCs, so long as a suitable distribution of resources in terms of both quantity and diversity was ensured throughout resource allocation. Energy efficiency in flexible DCs may be maximized. When memory-intensive workloads are deployed, the decomposition of typical DC servers at rack-scale results in higher savings (6-20%) as overall power expense than saved (5-8%) obtained when provisioning CPU-intensive operations.

REFERENCES

[1] Abali, R. J. Eickemeyer, H. Franke, C.-S. Li, and M. A. Taubenblatt, "Disaggregated and optically interconnected memory: When will it be cost effective?," Mar. 2015, arXiv:1503.01416 [cs.DC]

[2] Ajibola, T. E. H. El-Gorashi, and J. M. H. Elmirghani, "On energy efficiency of networks for composable datacentre infrastructures," in Proc. 20th Int. Conf. Transparent Opt. Netw., 2018, pp. 1–5.

[3] Ali, A. Q. Lawey, T. E. H. El-Gorashi, and J. M. H. Elmirghani, "Energy efficient disaggregated servers for future data centers," in Proc. 20th Eur. Conf. Netw. Opt. Commun., 2015, pp. 1–6.

[4] Benson, A. Akella, and D. A. Maltz, "Network traffic characteristics of data centers in the wild," in Proc. 10th ACM SIGCOMM Conf. Internet Meas., 2010, pp. 267–280.

[5] Dong, T. El-Gorashi, and J. M. H. Elmirghani, "Green IP over WDM networks with data centers," J. Lightw. Technol., vol. 29, no. 12, pp. 1861–1880, Jun. 2011.

[6] Dong, T. El-Gorashi, and J. M. H. Elmirghani, "IP over WDM networks employing renewable energy sources," J. Lightw. Technol., vol. 29, no. 1, pp. 3–14, Jan. 2011.

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[7] Kandiraju, H. Franke, M. D. Williams, M. Steinder, and S. M. Black, “Software defined infrastructures,” IBM J. Res. Dev., vol. 58, no. 2/3, pp. 2:1–2:13, Mar. 2014.

[8] Katayama and A. Okazaki, “Optical interconnect opportunities for future server memory systems,” in Proc. IEEE 13th Int. Symp. High Perform. Comput. Architecture, 2007, pp. 46–50.

[9] Katrinis et al., “Rack-scale disaggregated cloud data centers: The dReDBox project vision,” in Proc. Des., Automat. Test Europe Conf. Exhib., 2016 pp. 690–695.

[10] Li et al., “Software defined environments: An introduction,” IBM J. Res. Dev., vol. 58, no. 2/3, pp. 1:1–1:11, Mar. 2014.

[11] Mohammad Ali, T. E. H. El-Gorashi, A. Q. Lawey, and J. M. H. Elmirghani, “Future energy efficient data centers with disaggregated servers,” J. Lightw. Technol., vol. 35, no. 24, pp. 5361–5380, Dec. 2017.

[12] Pagès, J. Peelló, F. Agraz, and S. Spadaro, “Optimal VDC service provisining in optically interconnected disaggregated data centers,” IEEE Commun. Lett., vol. 20, no. 7. pp. 1353–1356, Jul. 2016.

[13] Papaioannou, R. Nejabati, and D. Simeonidou, “The benefits of a disaggregated data centre: A resource allocation approach,” in Proc. IEEE Global Commun. Conf., 2016, pp. 1–7.

[14] Roozbeh et al., “Software-defined ‘hardware’ infrastructures: A survey on enabling technologies and open research directions,” IEEE Commun. Surveys Tuts., vol. 20, no. 3, pp. 2454–2485, Jul.–Sep. 2018.

[15] Saridis et al., “DORIOS: Demonstration of an all-optical distributed CPU, memory, storage intra DCN interconnect,” in Proc. Opt. Fiber Commun. Conf., 2015, Paper. W1D.2.